DDF annual report

Title of Investigation:

Inflatable Reentry Vehicle Experiment (IRVE)

Principal Investigator:

Michael C. Cropper (Code 548)

Other In-house Members of the Team:

Herbert Morgan (Code569) and Elizabeth L. West (Code 840)

Other External Collaborators:

None

Initiation Year:

FY 2004

Aggregate Amount of Funding Authorized in FY 2004 and Earlier Years:

$0; One Full-Time Equivalent (FTE)

Funding Authorized for FY 2005:

$0; 0.5 Full-Time Equivalents (FTEs)

Actual or Expected Expenditure of FY 2005 Funding:

In-house: 0.08 FTE to the Range and Mission Management Office (Code 840); 0.21 FTE to the Applied Engineering and Technology Directorate Mechanical Systems Branch (Code 548); and 0.21 FTE to the Applied Engineering and Technology Directorate Electrical Systems Branch (Code 569)

Status of Investigation at End of FY 2005:

Transition to the Sounding Rocket Program Office (Code 810)

Expected Completion Date:

June 2006

Purpose of Investigation:

The goal of this project is to develop and flight test an inflatable atmospheric entry vehicle on a sounding rocket. The Inflatable Reentry Vehicle Experiment (IRVE) project is a partnership between the NASA Langley Research Center (LaRC) and the Wallops Flight Facility (WFF). IRVE will be made up of a series of test flights conducted on sounding rockets. Each test will build on the previous test to achieve increasingly difficult technical objectives. The first flight will demonstrate the inflation and survivability of the inflatable aeroshell. An aeroshell is an upside-down, cone-shaped covering that protects a spacecraft from the extreme heat generated during atmospheric entry. The first test flight will occur on a Terrier Improved Orion launch vehicle from Wallops Island, VA.

Accomplishments to Date:

Ballistic range testing of a scaled down IRVE shape was conducted at the Aeroballistic Research Facility (ARF), located at Eglin Air Force Base in Florida in December 2004. Data from the range indicated that the IRVE shape is both statically and dynamically stable from hypersonic through subsonic flight.

ILC Dover also was awarded the construction contract for making the inflatable material that covers the IRVE. ILC Dover has constructed both a Pattern Validation Unit (PVU) and a Design Validation Test (DVT) unit of the first bladder section for the inflatable body. The PVU was constructed of materials that the inflatable manufacturer had in stock. They were similar (as far as construction is concerned) to the flight materials. This unit allowed the manufacturer to refine construction techniques for the IRVE inflatable configuration without sacrificing expensive, long lead-time flight materials. Once the shape produced by the PVU was deemed acceptable, the DVT (another prototype of the first IRVE bladder volume) was constructed from the proposed flight materials. Shortcomings in the initial design concept were discovered with the DVT and the unit was modified to eliminate the problems. The DVT changes have been incorporated into the design of the flight unit. The DVT was delivered to LaRC in March 2005 for additional testing. Unfortunately, some of the modifications to the DVT prevented using the unit for vacuum leak testing, but other tests were still possible. The DVT was inflated in a radio frequency (RF) lab and the inflated structure was tested to verify that it would not interfere with transmission of telemetered data during the flight. Structural transient response testing also was performed on the DVT to help refine the structural models of the IRVE.

ILC Dover delivered the 3-m reentry vehicle test article to LaRC in mid-November. It has been installed in the LaRC's 16-m vacuum sphere for deployment, modal, and leak-rate testing. Pyrotechnic firing wiring and inflation line plumbing have been concluded on the test article. The first of a series of vacuum chamber test have begun and the initial results are encouraging.

Planned Future Work:

Upon successful completion of the Critical Design Review, the fabrication and manufacturing phase will begin on the launch vehicle, the flight aeroshell structure and inflation system, and the aeroshell's electrical and telemetry systems. Once this phase is completed, integration and testing of both the reentry vehicle and the launch vehicle will begin. Launch operations are currently scheduled for June 2006. Analysis of the flight results will occur shortly thereafter, with the resulting knowledge incorporated into the next follow-on flight as part of this continuing spiral-development effort.

Key Points Summary:

IRVE will advance inflatable-aeroshell technology toward the ultimate goal of providing a low-mass means of returning payloads or people from Earth orbit and delivering payloads to Mars and other atmospheric planetary bodies. Inflatable aeroshells could become a low-mass replacement for rigid aeroshells, which provide thermal protection during reentry into the atmosphere. IRVE will demonstrate this concept; establish requirements for inflatable materials, inflation systems, and control systems; and improve design and fabrication techniques. Programmatic innovations in sounding rockets include development of a larger customer base and increased recognition within the Agency of the program's capabilities and potential contributions.

For the Goddard Space Flight Center, the program will demonstrate:

- The potential for using sounding rockets to advance technologies that could apply to the new Vision for Space Exploration,
- How the Wallops Test Range can be used to support low-technology readiness level (TRL) atmospheric entry technologies, and
- Inter-Center partnerships that can lead to future opportunities.

We will consider the effort successful when the reentry vehicle is launched and deployed at an altitude greater than 80 km; when the reentry vehicle inflates and maintains inflation at an altitude greater than 80 km; and when the reentry vehicle attitude, flight path, thermal, and bladder pressure data can be generated and captured throughout reentry.

The original launch date for this project was March 2005, but the date slipped to June 2006 because of technical challenges discovered during IRVE subsystem and system testing. These setbacks are to be expected when developing new spaceflight technology. The primary goal of this project is to advance inflatable aeroshell technology and to conduct a safe and successful flight.